system of colour nomenclature might be devised by indicating colours in a manner analogous to the accepted nomenclature of the points of the compass.

In this connection the enclosed circular, published by me during the summer of 1893, to explain briefly my system of colour standards, may be of interest to your readers. You will see that the system of colour nomemclature here described corresponds almost precisely to the idea in Mr. Spencer's mind.

October 24. LOUIS PRANG.

[WE have received, with Mr. Prang's letter, the circular descriptive of his system, which is essentially the same as that suggested by Mr. Spencer. As Mr. Spencer pointed out in his letter to us, the idea is a very obvious one, and had probably occurred to others; but this does not, of course, diminish its value. For ourselves, we are glad to see that the idea has been put into practice, and that, out of a chaos of colour-names, an intelligent system of nomenclature has been evolved. A series of standard coloured papers, harmoniously bound together, is published by the Prang Educational Company, Boston, for the use of teachers, designers, artists, and others.—ED. NATURE.]

RECENT IMPROVEMENTS IN LIGHTHOUSE ILLUMINATION.

PRIOR to the year 1822, the optical apparatus used in the best equipped lighthouses was silver-plated parabolic reflectors, having apertures, twenty-one inches for fixed, and twenty-five inches for revolving lights, their focal distance being four inches. These instruments, with a burner one inch diameter, and an initial power of eleven candles, condensed the light into a beam of 1304 and 2360 candles respectively. The power of a first order reflector light of sixteen reflectors, ranged on a frame having four faces, was equal to 9340 candles. These were the instruments (Fig. 1) which A. Fresnel, the celebrated physicist, replaced by optical apparatus of glass lenses and prisms acting by refraction and reflection in combination with a central lamp and multiple-wick burner of considerable power. In doing so he devised four optical agents: the annular lens, totally reflecting prisms, the cylindric refractor for small apparatus, and straight vertical reflecting prisms. These instruments he combined in different ways to form fixed and revolving apparatus suitable for lighthouse purposes. The annular lens subtended at the focus 45° vertically and horizontally, the focal distance being 920 m.m. (36·22 inches). Some of Fresnel's optical instruments in the hands of Mr. Alan Stevenson, underwent very notable alteration, extension, and improvement. The first order lens was extended to subtend 57° vertically, and reflecting prismatic rings were substituted below the lenses for silvered mirrors. The central portion of the first order fixed light apparatus (Fig. 2) was converted from a polygon formed of narrow lenses to a cylindrical drum, which drum was divided into sections having helical joints, and above and below the central belt reflecting prisms were introduced.

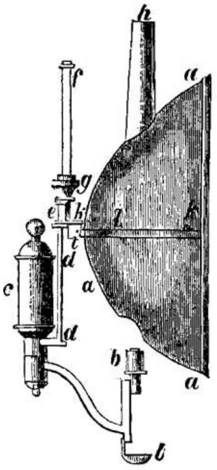


FIG. 1.

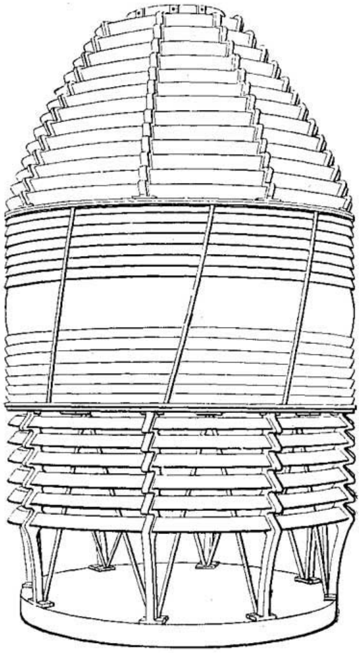


FIG. 2.

The next improvements were those of 1849–1850, by Mr. Thomas Stevenson, the main feature of which was that, for revolving lights, totally reflecting prisms generated round a horizontal axis were introduced above and below the lenses, lenticular action being thus extended throughout the whole height of the instrument (Fig. 3).

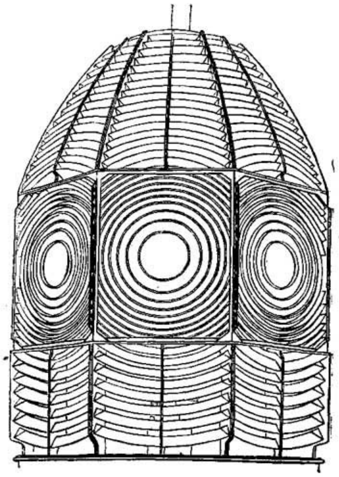


FIG. 3.

Then followed the dioptric spherical mirror, the dioptric holophote, the azimuthal condensing system, and its application to fixed, flashing, intermittent, and group flashing lights; the bivalve apparatus of 1859, which is really two holophotes ten feet in diameter, increased in power by a dioptric mirror, and numerous combinations of these and previously devised instruments.

One of the most notable of recent improvements is the hyper-radiant apparatus of 1330 m.m. or even greater radius, proposed by Messrs. Stevenson in 1869 (Fig. 4). This apparatus was designed to take advantage of the large and powerful flames of burners of greater diameter than five-wick; the introduction of burners of increased size having been inaugurated by Mr. Wigham in connection with his gas burners, and rendered possible, on financial grounds, with oil burners, by the introduction of paraffin. With revolving apparatus of 920 m.m. radius, it was clearly demonstrated that with burners of large diameter, much of the light, being exfocal, escaped condensation, and hence the hyper-radiant apparatus was designed to utilise and condense the rays proceeding from the large radiant. The light from one of the lenses of a hyper-radiant apparatus is more intense with the same size of burner in the focus than that from two lenses of 920 m.m. The hyper-radiant is now largely used by all lighthouse authorities. In 1872, Mr. Wigham suggested a very obvious method of increasing the power of a lighthouse by superposing in the lantern two, three, or four lenses, each with its own burner. Such arrangements have been introduced at several lighthouses, both in Ireland and England, but it is difficult to see what the advantage is, as it is quite easy with a single apparatus, properly designed, and single burner to get the same power and at a less cost. Mr. Charles A. Stevenson designed a form of refractor which is spherical in the horizontal and vertical planes, and this form was adopted in the apparatus of North Fair Isle lighthouse. The spherical refractor, if it has spherical profiles, loses in efficiency if carried beyond an angle subtending 20° at the focus, but when this design has combined with it Mr. C. A. Stevenson's equiangular prisms, as in the design for Sule Skerry lighthouse, there is less divergence, and hence less loss of light, than is the case with the Fresnel forms; in the case of the spherical lens, from the fact of its greater radius, and in the equiangular, from the prisms being of profiles of minimum divergence for exfocal light. In the design for Rattray Head apparatus, the equiangular prisms have been adopted to enable the lens to be carried to 80° of a vertical angle, the prisms at this high angle of refraction still remaining of good efficiency; whereas when lenses are carried to this high refracting angle by Fresnel's prisms, the lenses become very ineffective, owing to their great divergence for exfocal light. In recent designs by Messrs. Stevenson, of optical apparatus for New Zealand, lenses equiangular throughout have been introduced (Fig. 5).

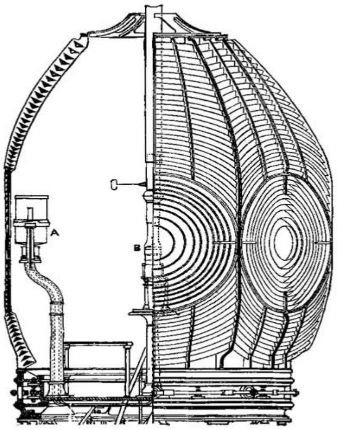
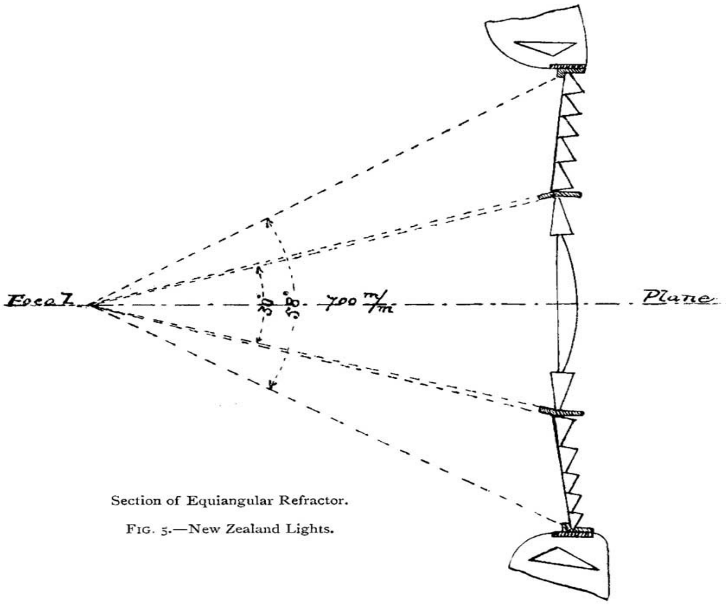


FIG. 4.



Section of Equiangular Refractor.

FIG. 5.—New Zealand Lights.

The increased and ever-increasing speed of steamships has necessitated the adoption, for over-sea and prominent lighthouses, of revolving, flashing, and group flashing apparatus, having short periods of light and darkness. This is desirable in order that the sailor may be able, in a short space of time, without appeal to a watch, to tell the character of the light he sees. But long before the days of fast steamers, Mr. R. Stevenson recognised the desirability of shortening the periods of light and darkness, and in 1825 he introduced the "flashing" distinction on the coast of Scotland, having periods of 5″ light and 5″ darkness. Subsequent experience has fully proved the utility of this striking characteristic. In 1874, Dr. Hopkinson proposed the important group flashing characteristic, which has since been largely adopted.

The length of the duration of a flash to be effective has been lately much discussed by lighthouse engineers and is a matter of great importance, for the shorter the flash can be made with efficiency, the stronger it can be made. Messrs. Stevenson have, in recent years, been gradually reducing the length of the flashes in apparatus designed by them, and in the case of the Isle of May electric light, installed in 1886, they reduced the flashes to half-second duration. They have not been followed in this by the lighthouse engineers of other countries, as, for example, in the case of St. Catherine's, lighted in 1888, where the flashes are 5″ duration. The French lighthouse engineers, however, have gone further, and within the last two years have designed lights, the duration of the flashes being only one-tenth second. This is going to the other extreme. M. Bourdelles and M. Blondel, in papers read before the International Maritime Congress, 1893, give the grounds on which they advocate such short flashes. They say, and say truly, that physically even less than one-tenth second is sufficient to make the maximum impression on the eye, and conclude that a longer duration is therefore unnecessary. This would be a sound conclusion were the atmosphere always clear, but it is not so. Now it is physically true, as they admit, that the duration necessary for the full effect of a flash depends on the intensity of the light; a weaker flash must have a longer duration than a stronger one, to make the full effect on the retina. But by the time a powerful flash has pierced a few miles of hazy atmosphere, it is no longer powerful, and if it has not a duration suitable to its reduced power, it will not be seen so far. This is a question which cannot be settled on merely theoretical grounds, but must inevitably be a matter of experience. The following are a few figures showing the great power of some modern lighthouse apparatus now in use in the Trinity House and Northern Lighthouse Services, as compared with anything employed during the days of colza oil, fixed lights, and apparatus of many sides.

The Isle of May light has a calculated intensity of no less than 26,000,000 candles to each flash, while the St. Catherine's electric light, calculated on the same basis, has a strength of beam equal to 5,000,000 candles. The power of the La Heve electric light is stated at 23,000,000 candles.

Turning now to the ordinary lights, where paraffin oil is the illuminant, the following may be mentioned as being of very great power. The Bishop Rock, biform, with two eight-wick burners and hyper-radiant apparatus, gives a flash of 175,000 candles. The Eddystone, with two six-wick burners and first order apparatus, gives a flash of 75,000 candles. Sule Skerry, with one six-wick burner and hyper-radiant apparatus, gives a flash of 74,000 candles, and Fair Isle North, one six-wick burner and hyper-radiant apparatus, without upper and lower prisms, gives a flash of 72,000-candle power.

The result of recent improvements in the optical apparatus used in lighthouses, and in the increased power of the lamps, is that the mariner is now getting the benefit of lights of greater intensity and more characteristic appearance, easily and rapidly recognisable.

THE DEPARTMENT OF ENTOMOLOGY IN THE U.S. NATIONAL MUSEUM.

THE staff of the Department of Insects of the U.S. National Museum has been reorganised, as a result of the death of the former Honorary Curator, Prof. C. V. Riley.

The reorganisation has been effected by the appointment of Mr. L. O. Howard, Entomologist of the U.S. Department of Agriculture, to the position of Honorary Curator of the Department of Insects; of Mr. Wm. H. Ashmead to the position of Custodian of Hymenoptera; and Mr. D. W. Coquillett to the position of Custodian of Diptera. All Museum custodians are honorary officers. Mr. M. L. Linell will remain as general assistant to the Honorary Curator.

The Department is at present in excellent working condition. It contains a very great amount of material in all orders, and in many unusual directions surpasses any collection in the United States. Among others, the following are of especial interest:—

(1) The large collection, in all orders, of the late Prof. C. V. Riley.

(2) All of the material gathered during the past eighteen years by correspondents, field agents, and the office staff of the Division of Entomology, U.S. Department of Agriculture.

(3) The greater part of the collection of the late Asa Fitch.

(4) The large collection, in all orders, of the late G W. Belfrage.

(5) The collections in Lepidoptera and Coleoptera made by Dr. John B. Smith down to 1889, together with the types of the Noctuidæ since described by Dr. Smith.

(6) The collection of Lepidoptera of the late O. Meske.

(7) The collection of Lepidoptera of G. Beyer.

(8) The collection of Coleoptera of M. L. Linell.

(9) The bulk of the collection, in all orders, of the late H. K. Morrison.

(10) The collection of Diptera of the late Edward Burgess.

(11) The type collection of Syrphidæ made by Dr. S. W. Williston.

(12) The collection of Ixodidæ of the late Dr. George Marx.

(13) The collection of Myriopoda of the late C. H. Bollman.

(14) Sets of the Neo-tropical collections of Herbert Smith.

(15) The collection of Hymenoptera of Wm. J. Fox.

(16) The collection of Tineina of Wm. Beutenmuller.

(17) The large Japanese collection, in all orders, of Dr. K. Mitsukuri.

(18) The African collections, in all orders, of Dr. W. S. Abbott, Wm. Astor Chanler, J. F. Brady, the last "Eclipse" expedition to West Africa, and of several missionaries.

(19) The large collection from South California of D. W. Coquillett, in Coleoptera, Hymenoptera, Lepidoptera and Orthoptera.

(20) The Townend Glover manuscripts and plates.

In addition to this material, there are minor collections which have been the result of the work of Government expeditions, or are gifts from United States Consuls and many private individuals.

This enormous mass of material is being cared for by the active and honorary force of the Department, and the perpetuity of the collection is assured. The National Museum building is fireproof, and this, together with the fact that it is a National institution, renders the Department of Insects, perhaps, the best place in the United States for the permanent deposit of types by working specialists in entomology, and for the ultimate resting-place of large collections made by individuals.

The policy of the Museum at large, with regard to the use of its collections by students, is a broad and liberal one. Students are welcome in all departments, and every facility is given to systematists of recognised standing.

NOTES.

IT is proposed by the Administrative Council of the Pasteur Institute to make an international appeal for subscriptions to erect a monument to the memory of Pasteur.

AN ordinary meeting of the Royal Society, for the reading of papers though not announced upon the printed list of arranged meetings, will be held on the 28th inst.

SIR ARCHIBALD GEIKIE and Prof. Story Maskelyne have been elected corresponding members of the Munich Academy of Sciences, in the Mathematical and Physical Section; and Dr. H. B. Swete, of Cambridge, has been elected a corresponding member in the Philosophical and Philological Section of the same Academy.

IN accordance with the arrangement mentioned in our last week's issue, Dr. A. G. Butler becomes Senior Assistant-Keeper of the Zoological Department of the British Museum, with special charge of the section of insects, and Mr. Edgar A. Smith and Dr. R. Bowdler Sharpe have been promoted to fill the two other assistant-keeperships. Mr. Vernon Herbert Blackman, of St. John's College, Cambridge, has been appointed, after competitive examination, an assistant in the Department of Botany, in the place rendered vacant by the promotions consequent upon the retirement of Mr. Carruthers.